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EXPERIMENTAL INVESTIGATION ON MECHANICAL PROPERTIES OF AISI 316L SS WELDMENT BY USING GTAW PROCESS

KEERTHI VASAN. T[1] & KUMARAVEL. K[2]

[1]*Assistant Professor, Department of Mechanical Engineering, M. Kumarasamy College of Engineering, Karur, India*

[2]*Assistant Professor, Department of Mechanical Engineering, Arulmurugan College of Engineering, Karur, India*

ABSTRACT

Welding is considered as one of the most important methods of metal joining process among other joing process. In this study, GTAW and Pulsed GTAW process is used to weld AISI 316L type of Austenitic steel(3)along with the filler material as ER 316L. Pure Argon is considered as shielding gas(2). For both the process, by using trial and error method, the mechanical properties like tensile strength, hardness was determined. And also mechanical properties of weldments using GTAW and pulsed GTAW were determined along with the identification of maximum strength in the above said two process

KEYWORDS: GTAW, Pulsed GTAW, Stainless Steel & Pure Argon

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Original Article

INTRODUCTION

In every Branch of manufacturing, the welding technology is considered as a major joining process of the same or different material. By the application of heat or pressure, a permanent joining process will happen and that will be named as welding process. Using this method the different materials like metals, alloys or plastics can be welded. The material to be joined using welding will be possible only when the interface regions melted and then the permanent join in h shall be achieved after the solidification process. In order to give a strong bond between two different or same material after a solidification, sometimes it is necessary to use a filler material to form a weld pool of molten material. In general, the welding can be classified as Fission and Fusion welding. The ability to weld a material or joining a material can be represented as Weldability Weldability of a material depends on different factors. Even though different welding techniques are available, Arc welding is considered as a type of welding that will produce high -quality welds when the welding process is taken care by well experienced personnel. In GTAW, the input parameters determine the quality of a weld. In order to achieve better economy and profitability it is required to go with the Optimum ranges of welding parameters. This can be achieved by conducting experiments and mounting the mathematical relationships between input and output process parameters. The different types of welding process include Arc Welding, Gas welding, oxyacetylene gas welding, Resistance welding, High energy beam welding, solid state welding.

GTAW WELDING

It is an arc welding process that produces welds with the help of non-consumable tungsten electrode. In this type, Argon or Heliumshallbeused as a Inert shielding gas. An electric round about fragment isthen made between the tungsten anode and the workpiece using an unfaltering current welding power supply that produces imperativeness and drove over the twist through a section of as toundingly ionized gas and metal vapors.

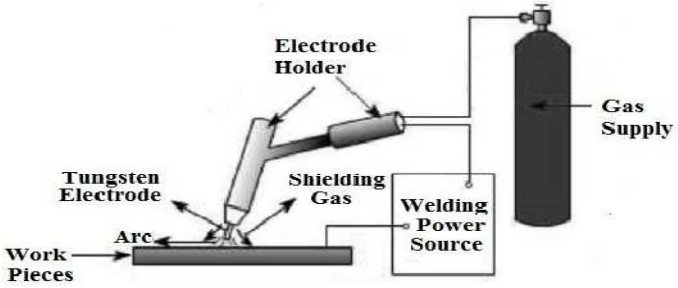


Figure 1: GTAW Basic Principal

The electric round part can pass on temperatures of up to 2000deg. celsius and this gleam can be secured to separate and join two diverse piece of material. The weld pool can be utilized to join the base metal with or without filler material. Amidst GTAW welding, a curve is kept up between a tungsten cathode and the workpiece in a lazy climate (Ar, He, or Ar-He blend). Subordinate up on the weldorche strating and the work-piece thickness, it is conceivable to work with or without a filler. The filler can be shown physically or half mechanically without display or just half mechanically under current. Tungsten cathodes are regularly open from 0.5 mm to 6.4 mm isolate a cross finished and 150-200 mm length. The present passing on the most remote purpose of each size of cathode relies on whether it is connected with negative or positive terminal of the DC control source. From this time forward, the run of the mill collections in the wind length, which happen in manual welding have little impact on the welding current. The ability to limit the current to the set respect is moreover fundamental when the terminal is short circuited to the workpiece, generally unnecessarily high current will stream, harming the anode. Open circuit voltage of essentialness source ranges from 60-80V

MATERIALS REQUIRED

GTAW welding process is chosen to carry out the experimental analysis of austenitic stainless steel.

- AISI 316 L Stainless steel
- ER 316L Filler Material

PROPERTIES OF AISI 316L STAINLESS STEEL

- Generally, the Grade 316L is following three important properties as follows.

MECHANICAL PROPERTIES

- Density (5000kg/m3)
- Poisson’s ratio (0.27-0.30)
- Elastic module (190-210gPa)
- Tensile strength (430MPa)
- Yield strength (170MPa)
- Elongation (40%)
- Hardness (95HRB. Max)

THERMAL PROPERTIES

- Thermal conductivity (16 W/m-k)
- Specific heat (500J/kg-k)
- Thermal expansion (17.2x10-6 deg. celsius)

ELECTRICAL PROPERTIES

- Electric resistivity (0.74x10-6 W-m)

METHODOLOGY

- Similar weld joint AISI 316L stainless steel is using ER 316L filler metal is performed by a GTAW welding process. The Focus on the similar joint of the AISI 316L using ER316L filler metal is to find the welding strength of the metals and to find the hardness value of the metals.
- The Hardness test is determined by using a Vickers hardness machine and tensile strength is determined by using Universal Testing machine.

EXPERIMENTAL WORK - MATERIAL DESCRIPTION

Figure 2: Base Metal: 75mm x 55mm x 3mm

Audit 316L the low carbon variation of 316 and is immune from honing. Stood out fromChromium-Nickel austeniticstainlesssteel, 316L offershigherslither, stress to break and flexibilityatliftedtemperatures Table.1.

Table 1: Chemical Composition of AISI 316L

C	Cr	Fe	Mn	Mo	Ni	P	S	Si
0.024	16.39	67.92	1.247	2.225	11.22	0.031	0.007	0.25

ER 316L filler metal is basically utilized for welding low carbon Molybdenum-bearing austenitic combinations. This low carbon compound isn't as solidathoisted temperatures as ER 316L.

Table 2: Chemical Composition of ER 316L

C	Cr	Ni	Mo	Mn	Si	P	S
0.015	18.75	12.25	2.50	1.80	0.34	0.010	0.010

PROCESS PARAMETERS FOR GTAW

In this examination, three level process parameters, i.e. welding current, voltage, and securing a gas stream rate are considered. The Constant paramètres, for instance, Workpiece Thickness, Wire bar removes over, welding speed, Welding frameworks are moreover considered in Table.3

Table 3: Process Parameters for GTAW

Thickness	Parameters	Value
3mm	Welding Current	100 Amps
	Welding Voltage	40 V
	Gas Flow Rate	6 lit/min

WELDED SPECIMEN

Figure 3(a): Specimen Before GTAW Welding

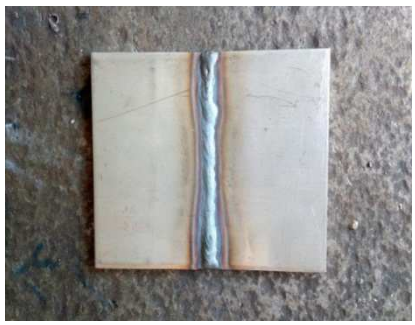


Figure 3 (b): Specimen After GTAW Welding

PROCESS PARAMETERS FOR PULSED GTAW

In this study, three Input parameters like Pulsed current, the Pulsed current duration, Welding speed also considered. The Constant paramètres such as Workpiece Thickness, Wireroddiameter, welding speed, Welding techniques are also considered.

Table 4: Process Parameters for Pulsed GTAW

Thickness	Parameters	Level 1
3mm	Pulsed Current	100 Amps
	Pulsed current Duration	40 milliseconds
	Welding Speed	6mm/min

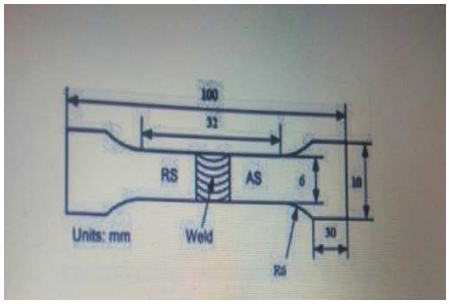
In the beat GTAW process, circular segment proficiency is taken as 60% . Amid the trial, voltage was found to fluctuate from 13.4 to 14.6 V. Henceforth, a mean the voltage of 14 V is taken for warm information estimation. The watched estimation of weld dot width, infiltration, welds dab territory, figured estimations of angle proportion and warmth contribution for beat GTA welded examples alongside the plan network are given in table.5

Table 5: Heat Inputs for Pulsed GTAW

Sl. No	Specimen	Heat Input
1	A	0.79 KJ/mm
2	B	0.67 KJ/mm

Figure 5: Specimen After Pulsed GTAW Welding

TENSILE TEST



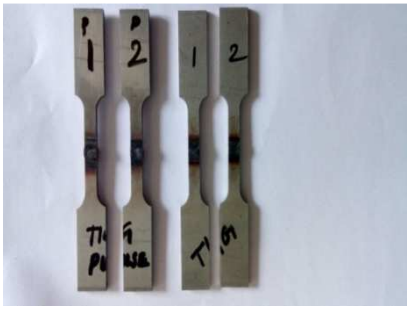


Figure 6(a): Dimensions Of Flat Smooth Tensile Specimen **Figure 6(b): AWS: B5 Tensile specimen**

The specimens for the tensile test were taken according to the AWS: B5. The tensile tests were tested on a universal testing machine for each of the 4 trials that are 2 for normal welding and 2 trials for pulse welding to be carried out. The root gap for both GTAW and pulse GTAW is provided 1mm.

RESULTS FOR TENSILE SPECIMEN (GTAW)

During GTAW welding on AISI 316Lwe have performed normal welding it is without a pulse the following tensile strength results may be taken as follows.

Specimen A: 700.267 N/mm^2

Specimen B: 717.130 N/mm^2

Average : 708.698 N/mm^2

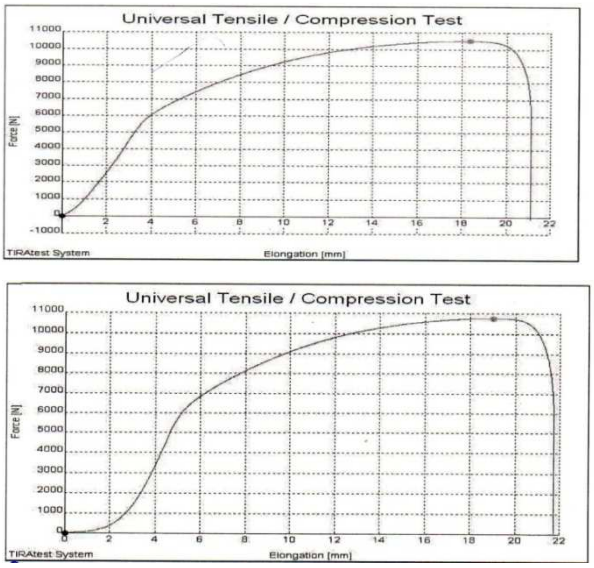


Figure 7: Stress-Strain Graph for Specimen A (GTAW)

RESULTS FOR TENSILE SPECIMEN (PULSED GTAW)

During GTAW welding on AISI 316L if we have perform pulse welding the following tensile strength results may be taken as follows.

Specimen A: 713.600 N/mm^2

Specimen B: 715.067 N/mm^2

Average : 714.333 N/mm^2

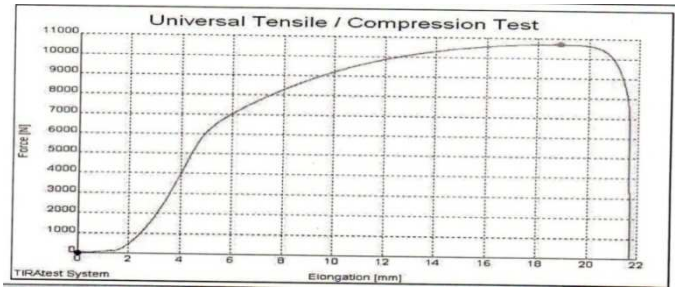


Figure 8: Stress-Strain Graph for Specimen A (Pulsed GTAW)

VICKERS HARDNESS TEST

From Vickers hardness test the results have as shown in table 6.

Table 6: Observed Vickers Hardness Value

Vickers Hardness	T1	T2	T3	Average
Weld metal **(GTAW)**	190	201	215	**202.000**
Weld metal (**GTAW Pulse)**	203	216	230	**216.333**

DISCUSSION AND CONCLUSIONS

The GTAW and pulsed GTAW welding process of AISI 316L austenitic stainless steel using ER316L filler metal is observed as good tensile strength and hardness of the weldment. From GTAW welding the observed tensile strength values of specimen A is 700.267 N/mm^2 and specimen B is 717.130 N/mm^2. From the above two values of GTAW, the average value of tensile strength is 708.698 N/mm^2.

From Pulsed GTAW welding, the observed tensile strength values of specimen A is 713.600 N/mm^2 and specimen B is 715.067 N/mm^2 and the average value of tensile strength of pulsed GTAW is 713.333 N/mm^2.

In this study, the Vickers hardness tests is used to determine the hardness of the weldments. From the observed value of GTAW, the weld metal hardness value is 202.000 VHN and for the Pulsed GTAW the hardness value is 216.333 VHN.

From the above two results of GTAW and Pulsed GTAW, the tensile strength and hardness of Pulsed GTAW is better than GTAW process. From this result, the Pulsed GTAW process gives the best mechanical properties of AISI 316L weldment.

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